REMARKS

Applicants respectfully request reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow. After amending the claims as set forth above, claims 1, 3-5, 10-18, 20-22, and 24-26 are now pending in this application.

Applicants wish to thank the Examiner for the careful consideration given to the claims.

Claim amendments

Claim 1 has been amended to recite "a metal burner membrane configured such that, during use, gas penetrates before being ignited and resulting in visible flames having a lower flame front where the gas ignites outside said membrane." Support for this feature can be found on page 8, lines 15-17 of the specification. Figure 3b of the present application shows, for example, how a lower flame front 310 is situated outside the membrane 305 that is formed by the foraminated metal plate 201' and the metal fibre fabric 305.

Rejection of claims 1, 5, and 22-25 based on Marrecau

Claims 1, 5, and 22-25 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over U.S. Patent 6,149,424 ("Marrecau"). For at least the following reasons, these rejections are traversed.

Claim 1 (as amended) recites, among other things, a metal burner membrane configured such that, during use, gas penetrates before being ignited and resulting in visible flames having a lower flame front where the gas ignites outside said membrane. The membrane comprises a fabric comprising stainless steel fibers, wherein the membrane of the gas burner comprises a base section having a smallest radius of curvature being R_{base}, a closing section, and a transition region connecting the base section to the closing section. The membrane is uninterrupted. The transition region has a smallest radius of curvature $r_{transition}$ being larger than or equal to 0.02 x R_{base} and being smaller than or equal to 0.7 x R_{base}. Marrecau does not teach or suggest this combination of features.

For instance, Marrecau does not teach or suggest a metal burner membrane configured such that, during use, gas penetrates before being ignited and resulting in visible flames having a lower flame front where the gas ignites outside said membrane. With this feature, it is clear to one of ordinary skill in the art that the gas burner of claim 1 operates in the "blue

flame mode."[1] This feature is also clear from the feature of claim 1 reciting the gas penetrating the membrane before being ignited. The difference between the gas burner of claim 1 working in "blue flame mode" and the radiant burner of Marrecau working in "radiant mode" is that in the former, the gas penetrates the membrane before being ignited. This difference is explained below.

In a gas burner operating in a "blue flame mode," the intention is to control the gas flow pattern as the gas is first ejected out of the burner and then the gas is ignited. If the gas flow is too high, it will blow off the flame. If the gas flow is too low, it will lead to flame extinguishment. (Page 1, lines 11-14 of specification.) The membrane itself serves to distribute the gas but the heat resistance of the membrane is not crucial as it does not heat up.[2] The purpose of a gas burner is to generate heat, not temperature. There is no interest in increasing the temperature for a gas burner but, quite the contrary, increased temperature leads to increased temperature cycles, which leads to wear on the assembly of the burner membrane. Thus, gas burners are grounded in the physics of fluid dynamics. In more concrete terms, the membrane of claim 1 does not heat up appreciably not even during use and does not emit a red glow. On the contrary, the membrane of claim 1 remains cool and can be touched as soon as the flames are gone.

A burner operating in a radiant mode, as disclosed in Marrecau, is designed to have combustion inside the membrane with substantially no external flame to make the membrane incandescent. (See page 1, lines 5-11 of U.S. 1,731,053, cited on page 3 of the Office Action.) The purpose of a burner working in radiant mode is to generate infrared radiation. This is achieved by having the combustion of the gas inside the membrane, whereby the generated heat immediately heats up the stainless steel which starts to emit radiation. The Stephan-Boltzmann law for black body radiation describes the emission of radiation to be proportional to the fourth power of the absolute temperature of the body. Hence, radiant burner designers will seek to increase the temperature of the burner membrane as much as possible to obtain more radiative output (e.g., above 1000°C as seen in the Table in column 4 of Marrecau.) Because not all stainless steels are able to withstand these high temperatures, special types of

[1] The name of the 'blue flame mode' finds its roots in natural gas emitting a bluish shine when burning. A gas burner working in blue flame mode is used, for example, to generate heat for household appliances.

[2] Note that, in the entire present application, the word "temperature" does not occur!

alloys are mandatory (such as FeCrAlY as disclosed in column 1, lines 50-51 of Marrecau). Radiant burners are used where radiation is needed, such as in drying operations, for example, to dry paper. Accordingly, in a radiant burner (such as the one in Marrecau), the intention is to increase the temperature of the membrane by having combustion inside the membrane. If the gas flow is too high, it will cool the membrane and reduce its radiation. If the gas flow is too low, it will lead to backflash explosion when the membrane starts to heat the internal gas. Thus, radiant burners are grounded in the physics of black body radiation.

In view of the above discussion, Applicants respectfully submit that the gas burner of claim 1 and the radiant burner of Marrecau are two different types of burners in which the physics governing both types of burners are totally different. Hence, a "gas burner" is not the same as a "radiant burner" but they are totally distinct apparatuses. As a result, the teachings from Marrecau cannot be applied to the invention of claim 1.

As previously mentioned, a metal burner membrane of claim 1 is configured such that, during use, gas penetrates before being ignited and resulting in visible flames having a lower flame front where the gas ignites outside said membrane. In Marrecau, however, the flame front during operation is inside the membrane (if this would not be so, it would not be a radiant burner). In the invention of claim 1, the flame front must be outside the membrane during operation.

Because Marrecau does not teach or suggest a metal burner membrane configured such that, during use, gas penetrates before being ignited and resulting in visible flames having a lower flame front where the gas ignites outside said membrane, claim 1 is allowable.

Furthermore, Marrecau does not teach or suggest that the transition region has a smallest radius of curvature $r_{transition}$ being larger than or equal to 0.02 x R_{base} and being smaller than or equal to 0.7 x R_{base}, as correctly stated on page 3 of the Office Action. The Examiner first asserts that the "radius of curvature of the base 16 near 20" of Marrecau is considered to be R_{base} of claim 1, the peaks 22 of Marrecau is considered to be the closing section of claim 1, and the right flank 24 of Marrecau is considered to be the transition region of claim 1. (Page 3 of the Office Action.) The PTO concludes that, because the base of 16 is wider than the top of 16, the radius of curvature of the "base radius of curvature is clearly larger than the transition radius of curvature." (Page 3 of the Office Action.) Even assuming a flame is present on the outside of the burner 10 (a point Applicants do not concede), when

interpreting the radii of curvature, the PTO considers the side of the membrane in which there is no flame. It is clear from the specification that the shape of the membrane must be considered from the side the flames are on. (See Figure 3b of the specification.) When interpreting the burner membrane in the correct way, it is clear that the radius of curvature of the flank 24 of Marrecau is larger than the radius of curvature of the base section 20. Hence, the inequality $r_{transition} \leq 0.7 \times R_{base}$ is definitely not obeyed because $R_{base} < r_{transition}$ when considering the membrane from the correct side, that is, from the side where the flames are.[3]

In any case, the claimed range of the smallest radius of curvature $r_{transition}$ being larger than or equal to 0.02 x R_{base} and being smaller than or equal to 0.7 x R_{base} cannot be derived from Marrecau because Fig. 1 (upon which the PTO relies) is not drawn to scale and only schematically explains the features of the radiant burner of Marrecau. (Column 2, lines 56-63 of Marrecau.) Thus, the dimensions shown in Fig. 1 of Marrecau are of little value for providing the claimed range of $r_{transition}$. (See MPEP 2125.[4]) Therefore, claim 1 is allowable over Marrecau.

The PTO also asserts:

> Marrecau teaches that by providing the radiant burner with an undulated burner membrane as apposed [sic] to a flat burner membrane, the temperature of the membrane is substantially increased. The burner of Marrecau is provided with an undulated burner membrane for the purpose of increasing the surface area of the flame and also to radiate heat from the base of the membrane to the top of the membrane and thereby increasing the total radiant heat output of the burner. This undulated membrane functions in the same manner as claimed by the application. The membrane is formed out of two porous structures, 16 and 18, which are stainless steel and knitted FeCrAlY fibers respectfully. When bent into shape the perforated membrane inherently has different level of porosity throughout the curvature of the membrane. In areas where the membrane has a lower radius of curvature, the mesh structure of the membrane will be more dense and be more prone to inhibit the flow of gas, which would slow the flow rate (velocity) of the gas. In areas where the radius of curvature is higher, the mesh structure would not be as compacted and therefore would more easily allow gas to penetrate the membrane, this would result in a high flow rate (velocity).

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[3] Again assuming a flame is present on the outside of the burner 10 (a point that Applicants do not concede).

[4] "When the reference does not disclose that the drawings are to scale and is silent as to dimensions, arguments based on measurement of the drawing features are of little value. See *Hockerson-Halberstadt, Inc. v. Avia Group Int'l*, 222 F.3d 951, 956, 55 USPQ2d 1487, 1491"

> It would have been obvious...to optimize the range of the transition radius of curvature of Marrecau for the purpose of optimizing the heat output range of the radiant burner. It is well known to someone of ordinary skill in the art that an undulated burner membrane can raise the heat output of a radiant burner higher than a conventional flat type radiant burner. Therefore, it would have been obvious to optimize the range of the transition radius of curvature of Marrecau's burner membrane to obtain a desired heat output of the radiant burner. (Pages 3-4 of the Office Action.)

It is respectfully submitted that this analysis is incorrect. As to the assertion that the undulated membrane of Marrecau functions in the same manner as that of the membrane of claim 1, nowhere in Marrecau is the need for different gas speeds on the membrane discussed. Quite the contrary (and as previously discussed), Marrecau is concerned with radiant burners so the gas speed outside the membrane should be zero or close to zero as otherwise the combustion starts to exit the membrane. Furthermore, as previously mentioned, the gas burner of claim 1 and the radiant burner of Marrecau operation on two different principles so the membranes certainly do not function in the same manner.

Second, as to the assertion regarding mesh structures in which areas with lower radii of curvature lead to a compacted mesh structure with lower gas speed and areas with higher curvature radii lead to a stretched mesh structure with higher gas speeds, this analysis is merely speculative with no support in Marrecau and factually inaccurate. When a constant flow of gas is fed through an orifice, such as a tube, the number of atoms per unit time that pass the tube area is constant. With a constant flow rate, exit gas velocity will <u>increase</u> with decreasing aperture. Hence, the analysis by the PTO is flawed in that small radii of curvature leads to a compacted mesh structure with smaller openings hence <u>higher</u> gas speeds and a large radii of curvature leads to a less compacted structure with larger openings hence <u>lower</u> gas speeds. This situation is just the opposite of what is described in the present application. The concepts of the amount of gas flow rate (number of gas molecules passing a certain area per unit of time) should not be confused with the velocity of the molecules. The flow rate of a gas through a tube is equal to the velocity of the gas times the area perpendicular to that velocity. The flow rate and the velocity definitions cannot be intermingled.[5] On the other hand, the basic idea of the invention of claim 1 is that the exit velocity of the gas is modulated

[5] In any case, the present application mentions on page 7, lines 16-18 that "the deformation of the plate is not relevant to the flow speed of the gas "as the hole size is relatively large."

by the local curvature of the membrane. Smaller radii of curvature result in a lower gas velocity, because the gas can expand more when exiting a curved (i.e. lower radius of curvature) burner surface than when exiting a flat surface where the velocity pattern in the gas stream remains constant at parallel planes above the flat surface.

As to the assertion that it would have been obvious to optimize the range of the transition radius of curvature of Marrecau's burner membrane to obtain a desired heat output of the radiant burner, Marrecau is clearly concerned with obtaining as much radiant energy out of the same burner surface and using <u>the burner on that maximum output</u>. Marrecau does this by increasing the surface and by increasing the reflections from the surface to increase the temperature of the membrane to obtain a higher radiative power, i.e. the favored aspect of radiant burners. (Column 3, lines 10-15 and arrows 26 of Marrecau.) The optimization of the invention of claim 1 is of a totally different nature.[6] It was not the object to find the gas burner with the <u>highest</u> heat output for a given area but it is the goal to find the gas burner that can work with a heat input of 1 kW/dm^2 up to a heat input of 40 kW/dm^2 (a dynamic range of 16 decibel or dB). The task was not to invent a gas burner that could only work at 40 kW/dm^2.

In contrast, the radiant burner of Marrecau has been tested with heat inputs of 6740 W and 8499 W yielding radiative powers of 2544 W and 3167 W. (See Table in column 4 of Marrecau.) This is a very low dynamic range of 1:1.2 (a dynamic range of 0.8 dB). The radiant burner membrane of Marrecau is not suitable for having a large dynamic range for a gas burner because the geometry is not correct. The flow pattern out of the membrane on the flanks 24 (which have larger radii of curvature than the base sections 20) will have a higher gas velocity as the depressions where gas velocity will be lower. This is contrary to what is needed for a gas burner with a high dynamic range.

To put it another way, one of ordinary skill in the art would not optimize the radiant burner of Marrecau to arrive at the gas burner of claim 1 because they are completely different types of burners that have different optimized conditions based on different operating principles and concerns. One of ordinary skill in the art would not optimize the

[6] The purpose is to have the highest possible <u>dynamic</u> range with only one gas burner. (See page 1, lines 13-15; page 1, lines 27-28; page 3 lines 22-25; and page 8, lines 4-7.)

radiant burner of Marrecau in the same way that one would optimize a gas burner. Thus, any rejection based on optimization is improper, and claim 1 is allowable.

Claims 5, 22, and 24-25 depend from and contain all the features of claim 1, and are allowable for the same reasons as claim 1, without regard to the further patentable features contained therein.

Claim 23 has been canceled, which renders the rejection of this claim moot.

For at least these reasons, favorable reconsideration of the rejections is respectfully requested.

Rejection of claims 2-4, 10-11, and 20-21 based on Marrecau and Dewaegheneire

Claims 2-4, 10-11, and 20-21 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Marrecau and U.S. Patent 6,065,963 ("Dewaegheneire"). This rejection is traversed for at least the following reasons.

Claim 2 has been canceled, which renders the rejection of this claim moot.

Claims 3-4, 10-11, and 20-21 depend from and contain all the features of claim 1. As previously mentioned, Marrecau fails to disclose a metal burner membrane configured such that, during use, gas penetrates before being ignited and resulting in visible flames having a lower flame front where the gas ignites outside said membrane and that the smallest radius of curvature of the transition region $r_{transition}$ is in the range of $0.02 \times R_{base}$ to $0.7 \times R_{base}$. Dewaegheneire does not cure these deficiencies because Dewaegheneire does not teach or suggest the claimed range for $r_{transition}$ and does not teach or suggest moving the lower flame front of Marrecau. Thus, claim 1 and its dependent claims 3-4, 10-11, and 20-21 are allowable over Marrecau and Dewaegheneire.

Also, neither Marrecau nor Dewaegheneire is concerned with increasing the dynamic range of the gas burner membrane which is the prime concern of the invention of claim 1. (See page 1, lines 26-27; page 3, lines 11-27; and page 8, lines 19-22 of the specification.) Neither Marrecau nor Dewaegheneire discusses the impact the radii of curvature has on the flame front (see Fig. 3b and page 8, lines 11-17 of the specification.) Indeed, the surface as explained in Marrecau would oppose the teaching of the application as the flow out of the membrane in the recess 26 of Fig. 1 of Marrecau would lead to an increased gas flow because both gas streams would combine together. Thus, one of ordinary skill in the art would not be

able to combine Marrecau and Dewaegheneire to arrive at the invention of claim 1. Thus, claim 1 and its dependent claims 3-4, 10-11, and 20-21 are allowable over Marrecau and Dewaegheneire.

Furthermore, it is clear that the combination of Marrecau and Dewaegheneire does not teach or suggest all of the features of claim 10 or 11.

Claim 10 recites "wherein said base section has a shape of a conical surface of a frustum of a cone." Marrecau teaches the importance of having surfaces mutually facing one another in order to increase the thermal output of the burner membrane. (Column 2, lines 19-24 of Marrecau.) It is described that the surface area of the burner membrane within its holding rim must be at least 5% higher than a flat surface within the holding rim, in order to obtain a sizeable increase in radiation efficiency. (Column 1, lines 30-36 of Marrecau.) Nowhere is it disclosed in Marrecau that there is a concern about the geometrical radii of curvature being important for the increase of the dynamic range of the gas burner (as described in the present application) or that the base section has the claimed shape of a conical surface of a frustum of a cone.

Dewaegheneire is directed to solving the flaring problem occurring with large cylindrical surface gas burners, by giving them a cone shape, possibly truncated. The cone shape is beneficial in preventing the build-up of pressure at the top of the cone. (Column 1, lines 51-57 of Dewaegheneire.) Nowhere is it disclosed in Dewaegheneire that there must be a curved transition region between the cap and the cone surface when considering the cone surface to be the base section. Moreover, nowhere is it said in Dewaegheneire that the burner membrane must be uninterrupted and continue from the cone surface to the cap without a seam and that the transition region has a smallest radius of curvature $r_{transition}$ being larger than or equal to 0.02 x R_{base} and being smaller than or equal to 0.7 x R_{base}.

Claim 11 recites "wherein said base section has a cylindrical shape." The PTO states "see Fig. 1 where the base section clearly has a cylindrical shape." (Page 7 of the Office Action.) From the Office Action, it is unclear if "Fig. 1" is referring to Fig. 1 of Dewaegheneire or Fig. 1 of Marrecau. However, Fig. 1 of Dewaegheneire does not show a base section having a cylindrical shape For Marrecau, the mounting frame 13 of the gas-burner may be cylindrical in part but it is not part of the burner membrane and is not gas permeable. Therefore, the mounting frame 13 cannot be the base section of the membrane of

claim 1. Because neither Marrecau nor Dewaegheneire teaches or suggests a base section having a cylindrical shape, claim 11 is allowable.

For at least these reasons, favorable reconsideration of the rejection is respectfully requested.

Rejection of claims 12 and 16-18 based on Marrecau, Dewaegheneire, and Sterick

Claims 12 and 16-18 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Marrecau, Dewaegheneire, and U.S. Patent 2,822,799 ("Sterick"). This rejection is traversed for at least the following reasons.

Claims 12 and 16-18 depend from and contain all the features of claim 1. As previously mentioned, Marrecau and Dewaegheneire fail to disclose a metal burner membrane configured such that, during use, gas penetrates before being ignited and resulting in visible flames having a lower flame front where the gas ignites outside said membrane and that the smallest radius of curvature of the transition region $r_{transition}$ is in the range of $0.02 \times R_{base}$ to $0.7 \times R_{base}$. Sterick does not cure all these deficiencies. Thus, claim 1 and its dependent claims 12 and 16-18 are allowable over Marrecau, Dewaegheneire, and Sterick.

Furthermore, one of ordinary skill in the art would not combine Marrecau, Dewaegheneire, and Sterick in order to arrive at the claimed invention of claim 1 because the burners of Sterick are concerned with the reflecting of heat using metal fibers. (Column 1, lines 58 to column 2, lines 5 of Sterick.) Although there is a plurality of holes 8b and 15a for venting the fumes from the burner, there is no reason to use the metal shield 8 or 15 of Sterick as a burner membrane through which gas penetrates. The use of the heating unit of Sterick with the burners of Marrecau and/or Dewaegheneire to arrive at the gas burner of claim 1 is not straightforward as they concern total different types of burners wherein the fibers are used as insulation materials in one instance and a material for a burner membrane in another instance.

Furthermore, the use of the shield 8 or 15 of Sterick in the membrane of either Marrecau or Dewaegheneire changes the function of the shield of Sterick, which makes the proposed modification non-obvious. MPEP 2143 suggests that a conclusion that a claim would have been obvious when all the claimed elements were known in the prior art, one of ordinary skill in the art could have combined the elements with no change in their respective

functions, and the combination yielded nothing more than predictable results cannot be made if there is a change in the function of the element found in the prior art. Because the shield of Sterick has a change in function from a reflector of heat to a burner membrane where gas penetrates therethrough in the proposed combination, the proposed modification based on the teachings of Sterick is improper, and claim 1 and its dependent claims 12 and 16-18 are allowable.

For at least these reasons, favorable reconsideration of the rejection is respectfully requested.

Rejection of claims 13-15 based on Marrecau, Dewaegheneire, and Karlovetz

Claims 13-15 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Marrecau, Dewaegheneire, and U.S. Patent 3,857,670 ("Karlovetz"). Claims 13-15 depend from and contain all the features of claim 1. As previously mentioned, Marrecau and Dewaegheneire fail to disclose a metal burner membrane configured such that, during use, gas penetrates before being ignited and resulting in visible flames having a lower flame front where the gas ignites outside said membrane and that the smallest radius of curvature of the transition region $r_{transition}$ is in the range of $0.02 \times R_{base}$ to $0.7 \times R_{base}$. Karlovetz does not cure all these deficiencies. The gas burner membrane of Karlovetz is consistently identified with number 18 in the patent. However, it is mentioned that "[t]he central portion of layers of mesh are welded to each other at the points indicated by the reference number 23 and, after welding, the central portions are coined convex" for pre-establishing the direction of expansion of the screen. (Column 4, lines 32-34 of Karlovetz.) Fig. 6 of Karlovetz shows that the bulging is slight and the curvature does not meet the claimed range of $r_{transition}$ of claim 1. Moreover, the burner membrane is built up of different meshes and not from stainless steel fibers. Karlovetz, therefore, does not cure the deficiencies of Marrecau and Dewaegheneire, and claim 1 and its dependent claims 13-15 are allowable over Marrecau, Dewaegheneire, and Karlovetz. For at least these reasons, favorable reconsideration of the rejection is respectfully requested.

Allowability of claim 26

Claim 26 depends from and contains all the features of claim 1, and is allowable for the same reasons as claim 1. Furthermore, claim 26 recites "wherein the smallest radius of

curvature R_{base} of the base section and the smallest radius of curvature $r_{transition}$ of the transition region are determined from a side of the membrane which faces the flames." None of Marrecau, Dewaegheneire, Sterick and Karlovetz teaches or suggests this features. For example, when Marrecau is interpreted such that the smallest radius of curvature R_{base} of the base section and the smallest radius of curvature $r_{transition}$ of the transition region are determined from a side of the membrane which faces the flames, it is clear that the radius of curvature of the flank 24 of Marrecau is larger than the radius of curvature of the base section 20. Hence, the inequality $r_{transition} \leq 0.7 \times R_{base}$ is definitely not obeyed because $R_{base} < r_{transition}$ when considering the membrane from the correct side, that is, from the side where the flames are.[7] For at least these reasons, allowance of claim 26 is respectfully requested.

Conclusion

Applicants believe that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

[7] Again assuming a flame is present on the outside of the burner 10 (a point that Applicants do not concede).

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing or a credit card payment form being unsigned, providing incorrect information resulting in a rejected credit card transaction, or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicants hereby petition for such extension under 37 C.F.R. §1.136 and authorize payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

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